HOOKE'S LAW: NORMAL

- WORKS FOR ONLY ELASTIC MATERIALS!

$$\sigma_{11} = \frac{E}{(1+\nu)(1-2\nu)}\left[(1-\nu)\varepsilon_{11} + \nu(\varepsilon_{22}+\varepsilon_{33})\right]$$

$$\sigma_{22} = \frac{E}{(1+\nu)(1-2\nu)}\left[(1-\nu)\varepsilon_{22} + \nu(\varepsilon_{33}+\varepsilon_{11})\right]$$

$$\sigma_{33} = \frac{E}{(1+\nu)(1-2\nu)}\left[(1-\nu)\varepsilon_{33} + \nu(\varepsilon_{11}+\varepsilon_{22})\right]$$

$$\sigma_{12} = 2G\varepsilon_{12}$$
$$\sigma_{13} = 2G\varepsilon_{13}$$
$$\sigma_{23} = 2G\varepsilon_{23}$$

PRINCIPAL STRESS:

- COORD. PERPEN. TO SHEAR STRESSES.

$$\underset{\substack{\uparrow \\ \text{FIRST PRINCIPLE STRESS.}}}{\sigma_1} \geq \underset{\substack{\uparrow \\ \text{2ND}}}{\sigma_2} \geq \underset{\substack{\uparrow \\ \text{3RD...}}}{\sigma_3}$$

2D:

- STRESS TRANSFOR...

$$\sigma_{x'} = \frac{\sigma_x+\sigma_y}{2} + \frac{\sigma_x+\sigma_y}{2}\cos 2\theta + \tau_{xy}\sin 2\theta.$$

- PRINCIPLE STRESSES:

$$\sigma_{1,2} = \frac{\sigma_x+\sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x+\sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

- DIRECTION OF 2 PRINCIPLE STRESSES:

$$\theta_p = \frac{1}{2}\tan^{-1}\frac{2\tau_{xy}}{\sigma_x-\sigma_y}, \quad \theta_p = 90^\circ + \frac{1}{2}\tan^{-1}\left(\frac{2\tau_{xy}}{\sigma_x-\sigma_y}\right)$$

3D:

PRINCIPLE STRESS:

$$\begin{vmatrix} \sigma_{xx}-\sigma & \sigma_{xy} & \sigma_{xz} \\ \sigma_{yx} & \sigma_{yy}-\sigma & \sigma_{yz} \\ \sigma_{zx} & \sigma_{zy} & \sigma_{zz}-\sigma \end{vmatrix} = 0$$

$$\sigma^3 - I_1\sigma^2 + I_2\sigma - I_3 = 0$$

$$I_1 = \sigma_{xx} + \sigma_{yy} + \sigma_{zz}$$

$$I_2 = \begin{vmatrix} \sigma_{yy} & \sigma_{yz} \\ \sigma_{zy} & \sigma_{zz} \end{vmatrix} + \begin{vmatrix} \sigma_{xx} & \sigma_{xz} \\ \sigma_{zx} & \sigma_{zz} \end{vmatrix} + \begin{vmatrix} \sigma_{xx} & \sigma_{xy} \\ \sigma_{yx} & \sigma_{yy} \end{vmatrix}$$

$$= \sigma_{yy}\sigma_{zz} - \sigma_{yz}\sigma_{zy} + \sigma_{xx}\sigma_{zz} - \sigma_{xz}\sigma_{zx} + \sigma_{xx}\sigma_{yy} - \sigma_{xy}\sigma_{yx}$$

$$= \sigma_{yy}\sigma_{zz} - \sigma_{yz}^2 + \sigma_{xx}\sigma_{zz} - \sigma_{xz}^2 + \sigma_{xx}\sigma_{yy} - \sigma_{xy}^2$$

$$I_3 = \begin{vmatrix} \sigma_{xx} & \sigma_{xy} & \sigma_{xz} \\ \sigma_{yx} & \sigma_{yy} & \sigma_{yz} \\ \sigma_{zx} & \sigma_{zy} & \sigma_{zz} \end{vmatrix} = \sigma_{xx}\sigma_{yy}\sigma_{zz} + 2\sigma_{xy}\sigma_{yz}\sigma_{zx} - \sigma_{xx}(\sigma_{yz})^2 - \sigma_{yy}(\sigma_{zx})^2 - \sigma_{zz}(\sigma_{xy})^2$$